CHROMOSOME NUMBERS IN ULMUS AND RELATED GENERA

KARL SAX

With plate 56

The genus Ulmus contains about 18 species and a considerable number of varieties and hybrids (Rehder 1927). The genus is represented in the temperate regions of North America, Asia and Europe. Most species develop their pollen grains and flower early in the spring, but two species, *U. parviflora*, the Chinese Elm, and *U. serotina*, from south central United States, flower in early autumn. The other species have well developed flower buds in the fall but do not bloom until early spring.

Chromosome counts at meiosis were obtained from aceto-carmine smear preparations. Fourteen pairs of chromosomes were found in the following species and varieties,—the American species, *U. racemosa* and *U. fulva;* the European species, *U. laevis, U. glabra, U. procera purpurea* and *U. foliacea;* and the Asiatic Elms, *U. laciniata* and *U. japonica. Ulmus hollandica* varieties *Pitteursii* and *superba* also have 14 pairs of chromosomes, although there is occasionally some irregularity in the meiotic divisions of the variety *superba*. The American Elm, *U. americana* is a tetraploid with 28 pairs of chromosomes. There is, as might be expected, some indication of secondary chromosome pairing in the species. The variety *pendula* is also a tetraploid. It is probable that *U. americana* is an autotetraploid and that only bivalent chromosomes are formed because of the limited chiasma frequency.

The numerous varieties of *U. hollandica* are presumably segregates from hybrids between *U. glabra* and *U. foliacea*. The two varieties studied show only slight irregularities in meiotic divisions and pollen fertility is almost complete. It seems probable that a number of species hybrids could be made in this genus.

During the spring of 1932 crosses were made between *U. americana* and *U. laevis*. A considerable number of seeds were obtained, but owing to technical difficulties in pollination it is probable that many of the seeds were not of hybrid origin. Since *U. americana* is a tetraploid and *U. laevis* a diploid, the hybrid seedlings should be triploids. Chromosome counts from these seedlings have not been completed, but the seedlings examined seem to be tetraploids.

In general, the species of Ulmus constitute a rather closely related group as indicated by chromosome number and morphology, the ocurrence of fertile species hybrids, and the similarity of certain Old and New World species.

The related genus *Zelkova,* also has 14 pairs of chromosomes. The reduction divisions in *Z. serrata* seem to be regular.

The monotypic genus *Hemiptelea* is apparently a polyploid with a large number of chromosomes which are irregularly distributed at the meiotic divisions. About 70-80 per cent of the pollen of *H. Davidii* is morphologically imperfect.

Celtis occidentalis also has very irregular meiotic divisions. The diploid chromosome number is 28, but at the first meiotic division there is little chromosome pairing and the univalent chromosomes are irregularly distributed to the daughter nuclei. In some cases 28 univalents were observed at the first meiotic metaphase stage and in most cases only a few bivalents were found (Fig. 11). The chromosome behavior was the same in two different trees and in both cases at least 80 per cent of the pollen was sterile. A considerable number of fruits were produced on both trees.

The irregular chromosome behavior and high pollen sterility in a good species is difficult to understand. If this species contains two different basic sets of chromosomes with only a few homologous chromosomes or parts of chromosomes it could breed true only by some form of apomixis. Such true breeding hybrids are found in nature. *Malus theifera* for example is a triploid which produces no functional pollen, but it reproduces the type and has a natural distribution.

It is also possible that the prevalence of galls on *Celtis* may influence the meiotic divisions. Kostoff and Kendall (1929, 1930) have found that gall mites and other parasites may cause chromosome irregularity in certain solanaceous plants. Although no parasites were observed on the Celtis flowers collected it is perhaps possible that the residual effect of constant earlier infections may have had an influence on the meiotic divisions. If megasporogenesis is less easily disturbed a considerable number of fruits might be produced even though relatively few of the pollen grains are functional. Additional work on *C. occidentalis* and other species should be done to determine the cause of pollen sterility in this genus.

The basic chromosome number is 14 for all of the genera of the Ulmaceae investigated. Among the allied families the basic chromosome number is 16 for the Juglandaceae (Woodworth, 1930), 8 and 14 for Betulaceae, (Woodworth, 1931), 12 for the Fagaceae (Sax, 1930), and 14 for several genera in the Moraceae (Gaiser, 1930). From the standpoint of chromosome numbers the Ulmaceae might seem to be allied with the *Alnus, Betula, Corylus* group in the Betulaceae and *Morus* in the Moraceae, but the great diversity in morphological and anatomical characters would not seem to indicate any close phylogenetic relationships among these families.

CYTOLOGICAL LABORATORY, ARNOLD ARBORETUM
HARVARD UNIVERITY

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DESCRIPTION OF PLATE 56

Drawings from aceto-carmine preparations of pollen mother cells. × 2000. First meiotic metaphase shown in all figures except number 10 which is from a second metaphase plate.

Figure 1. *Ulmus laevis.*
Figure 2. *Ulmus americana pendula.*
Figure 3. *Ulmus racemosa.*
Figure 4. *Ulmus fulva.*
Figure 5. *Ulmus laciniata.*
Figure 6. *Ulmus procera purpurea.*
Figure 7. *Ulmus japonica.*
Figure 8. *Ulmus hollandica Pitteursii.*
Figure 9. *Ulmus foliacea.*
Figure 10. *Zelkova serrata.*
Figure 12. *Celtis occidentalis.*